Hello everybody, my name is Nathaniel Takle and I will be the Calculus Master tutor this year. I am here to help you excel in Calculus throughout the semester! My biggest tip for learning calculus is doing practice problems! If you are stumped by a practice problem, refer to videos that work the problem and explain the concept! The following is a link to the Baylor Tutoring YouTube page with videos on EACH concept that is covered during Calculus! (https://www.baylor.edu/case/index.php?id=978621) I would love to help you succeed in any way, please feel free to reach out to me at Nathaniel_Takle1@baylor.edu if you have questions or would like further explanation on a topic.

These resources are a culmination of the main topics learned each week. These are meant to provide you with explanations and more practice to master Calculus this semester!! Remember: The Tutoring Center offers free individual and group tutoring for Calculus.

**Calculus Group Tutoring sessions will be Mondays from 5:15-6:15 PM at the Sid Rich basement, room 74!**

You can reserve a spot at https://baylor.edu/tutoring. I hope to see you there!

**Keywords:** U-substitution, Rules of U-substitution, Finding C

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**Topic of the Week: U-Substitution**

This week as we progress further into integration, we are covering the methods of integrating. An important topic is u-substitution. This is a method that is similar to the inverse chain rule of derivatives.

First you must pick a u from you integrated equation, as the greater exponent or the function that is “in a function.”

Once you pick your u, (example: u=x+3) you must differentiate it. This will give you (du/dx) = ____. From this, you can solve for dx. Once you have it in terms of dx=____, you can substitute that in for dx where they substituted du/g'(x) for dx/.

This allows you to integrate in terms of u and then substitute your value of x back in for u once integrated.
To the left is a worked problem showing how to integrate the function.

First, they picked their u. This was $2x+1$ and they derived it to get $du/dx=2$.

Next, they plugged u in for $2x+1$ and $(du/2)$ in for dx. It is not seen because the two below the du cancelled with the 2 in the integral.

They then integrated in terms of u and plugged their x value for u back in.

- Video Resource:
  - https://www.youtube.com/watch?v=ANzdIA1vAQ

- Practice problem
  - $f(x) = \int 2x(3x^2 + 3)^7 dx$

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**Highlight: Rules of U-Substitution**

Rule for u substitution are as shown from your book.

Thin about the inverse of these integrals. The relation of the derivative of $\ln(x)$... to the integral of $1/x$.

These are helpful to know for when you run into high level integration problems in practice.

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<table>
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<th>Remark [Some Common Integrals]:</th>
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| i) Integral of a Constant: If $k$ is a constant, $\int k \, dx = kx + C$
| ii) Integral of a Power Function: For $n \neq 1$, $\int x^n \, dx = \frac{1}{n+1}x^{n+1} + C$
| iii) Integral of $\frac{1}{x}$: $\int \frac{1}{x} \, dx = \ln |x| + C$
| iv) Integral of $\frac{f'(x)}{f(x)}$: $\int \frac{f'(x)}{f(x)} \, dx = \ln |f(x)| + C$
| iv) Integral of the Exponential Function: $\int e^{ax} \, dx = \frac{1}{a}e^{ax} + C$

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<th>Remark [Suggestions for Substitutions]: If the integrand involves</th>
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| i) a rational function, $f(x) = \frac{g(x)}{h(x)}$, let $u = h(x)$.
| ii) a quotient with a natural logarithm in numerator, $f(x) = \frac{\ln(h(x))}{g(x)}$, let $u = \ln(h(x))$.
| ii) an exponential equation, $e^{f(x)}$, let $u = f(x)$.
| iii) a power or radical, $(f(x))^p$ or $\sqrt{f(x)}$, let $u = f(x)$.

- Video Resource
  - https://www.youtube.com/watch?v=ipOVrYi_LTE

- Practice problem
  - $f(x) = \int \frac{3x+6}{x^2+4x-3} \, dx$
**Highlight: Finding C**

Now, whenever we integrate we always put +C on the end (I hope everyone does!). How do we get rid of it? This is a common test problem but we are actually able to solve for C! You must repeat the process of integrating all the way as shown above. Next, we will be given a point (x,y) and we can plug these into our equation for x, and f(x), respectively. This leaves only one variable to solve for – C!

- **Practice Problem:**
  - f(x) = \int (x + 1)^2 dx and the line passes through the points (2,11)

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**Topics Commonly Struggled with:**

Things Commonly Struggle With

- Converting du/dx=___ to dx=du/___ and substituting.
- Remembering the rules for integrating

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**Example Problems:**

1) \( f(x) = \int 2x(3x^2 + 3)^7 dx \)

2) \( f(x) = \int \frac{3x+6}{x^2+4x+3} dx \)

3) \( f(x) = \int (x + 1)^2 dx \) and the line passes through the points (2,11)
1. Answer: \( F(x) = \frac{1}{24} (3x^2 + 3)^8 + C \)

2. Answer: \( F(x) = \frac{3}{2} \ln(x^2 + 4x - 3) + C \)

3. Answer: \( F(x) = \frac{(x+1)^3}{3} + 2 \) (C=2)